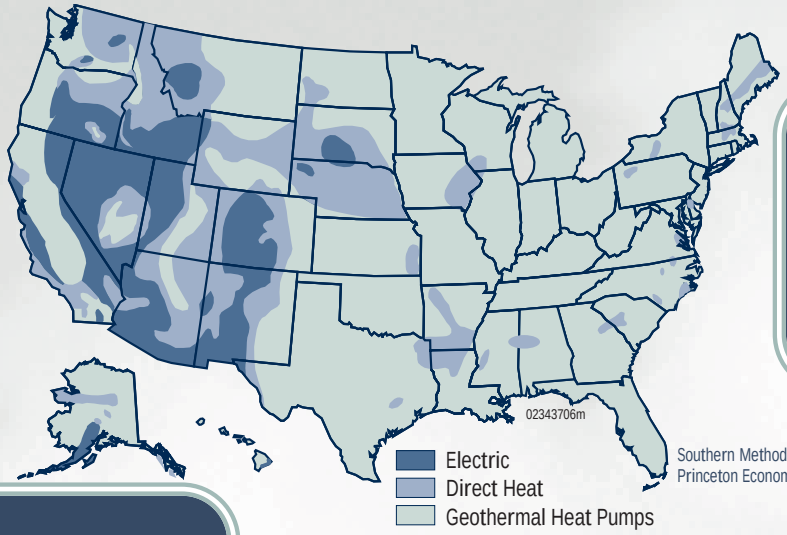


Much of the western United States has geothermal resources suited to electricity production and direct heating. The entire country is suitable for geothermal heat pumps.

Resources

Hydrothermal
resources are large volumes of fractured or porous hot rock that contain hot water. Water continually seeps into and collects in the fractured rock. These resources are tapped by drilling wells to deliver heat from the hot water to the surface for the generation of electricity or for direct heating. In the United States, these resources are located in the western states, Alaska, and Hawaii.

Shallow ground
the upper 10 feet of the Earth—has a nearly constant temperature between 50° and 60°F (10° and 16°C), and this rock, soil, and water form the resource tapped by geothermal heat pumps. The ground acts as a heat source in the winter and absorbs heat for cooling in the summer. All areas of the United States have nearly constant shallow-ground temperatures and are suitable for geothermal heat pumps.

Hot dry rock
resources occur at depths of 3–5 miles everywhere beneath the Earth's surface, and at lesser depths in certain areas. Access to these resources involves injecting cold water down one well, circulating it through hot fractured rock, and drawing off the heated water from another well. This technology appears to be feasible, but no commercial applications are in use at this time.

Magma (or molten rock)
resources offer extremely high-temperature, very deep sources of energy, but existing technology does not allow recovery of heat from these resources.

geothermal energy

Geothermal energy—the heat from the Earth—is the world's largest energy resource. It provides an important contribution to our nation's energy needs today and the potential for greater use tomorrow. Geothermal energy is generating electricity, heating communities and businesses, and heating and cooling homes. And, best of all, geothermal energy is a sustainable and clean energy resource.

Environmental Benefits

Geothermal energy is clean energy. Geothermal power plants emit no nitrogen oxides, very low amounts of sulfur dioxide, and 1/1000–1/2000 of the carbon dioxide emitted from fossil-fueled power plants. The use of geothermal water directly for heating and the use of geothermal heat pumps reduce the need for fossil-fuel generated heat.

Economic Benefits

Geothermal power plants are reliable and efficient, consequently they are cost effective. Taken as a group, they are available to generate power 95% or more of the time; they are seldom off-line for maintenance or repair.

The use of geothermal resources directly for heating reduces heating costs. For example, most greenhouse growers in geothermal areas estimate that using geothermal resources instead of traditional energy sources reduces heating costs by up to 80%, which can save about 5%–8% of their total operating cost.

Geothermal heat pumps reduce both heating and cooling costs compared to air source heat pumps and air conditioners in both residential and commercial buildings. They have low operating and maintenance costs, and, usually, lowest life-cycle costs of the available heating and cooling options. Consumption of electricity is reduced 25%–50% compared to traditional heating and cooling systems, allowing a payback of system installation costs in 0–10 years.

A Domestic Resource

Geothermal resources are domestic resources. Keeping the wealth at home translates to more jobs and a robust economy. And not only does our national economic and employment picture improve, but a vital measure of national security is gained when we control our own energy supplies.

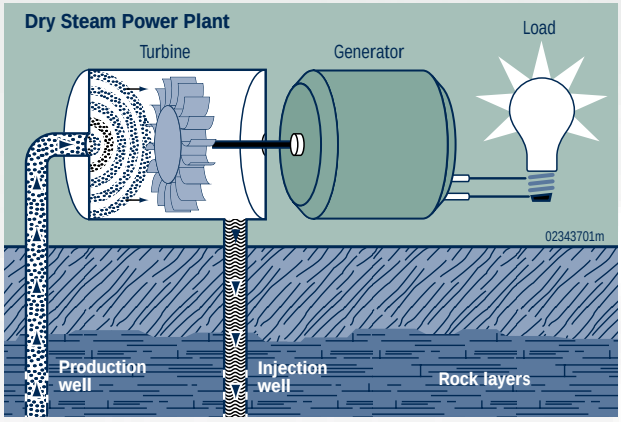
Geothermal Energy Today

- Can provide electricity to over 3 million people in the United States
- Heats more than 120 U.S. communities
- Heats and cools nearly 350,000 homes, schools, and businesses nationwide.

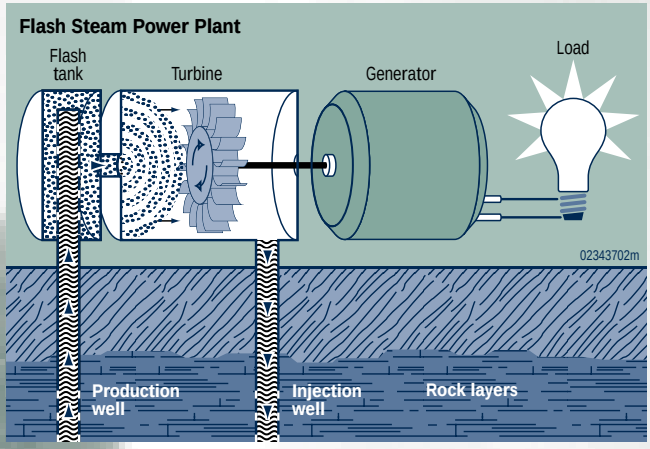
Electricity Production

In the United States, the installed generating capacity for geothermal energy is about 2700 megawatts. This provides enough electricity for over 3 million people. The cost of producing this power ranges from 2¢–7¢ per kilowatt hour.

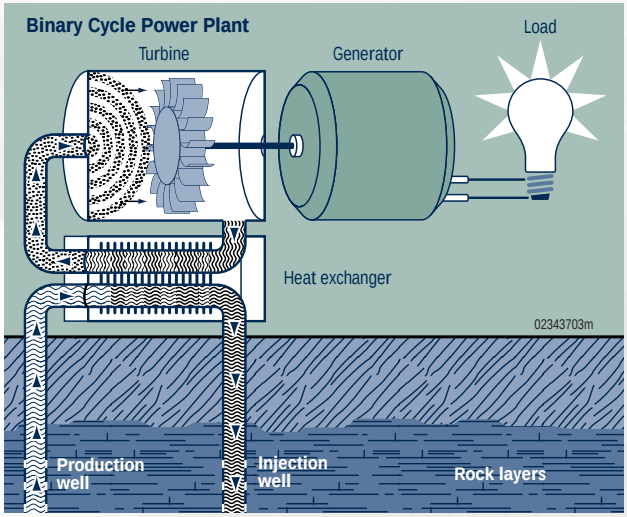
Dry Steam Power Plants use the steam as it comes from wells in the ground and direct it into a turbine/generator unit to produce power.

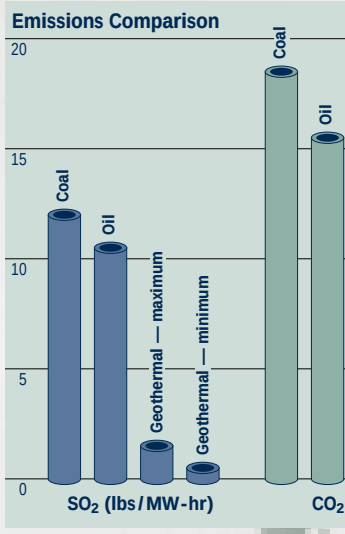


Flash Steam Power Plants, which are the most common, use water with temperatures greater than 360°F (182°C). This very hot water flows up the wells under its own pressure to the Earth's surface. The decrease in pressure as it flows upward allows some of the hot water to boil to steam. The steam is separated from the water, and the steam powers the turbine/generator. The hot water left over and any condensed steam are injected back into the rocks to make this a sustainable energy source.



Binary Cycle Power Plants operate on the lower-temperature waters, 225°–360°F (107°–182°C). These plants use the heat of the hot water to boil a "working fluid," usually an organic compound with a low boiling point. This working fluid is then vaporized in a heat exchanger and used to turn a turbine. The geothermal water and the working fluid are confined to separate closed loops, so there are no air emissions. The geothermal water is injected back into the rocks to be reheated.





Direct Use of Geothermal Energy

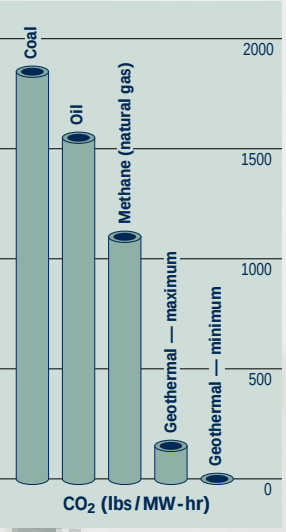
Hot water from geothermal resources can be used directly to provide heat for industrial processes, crop drying, or heating buildings. In direct use applications, a well brings hot water to the surface; a mechanical system—piping, heat exchanger, controls—delivers the heat to the space or process; and a disposal system either injects the cooled geothermal water underground or disposes of it on the surface.

In the United States alone, direct geothermal applications (not including geothermal heat pumps) have an installed capacity of 500 thermal megawatts. This includes approximately 40 greenhouses, 30 fish farms, 190 resorts and spas, 125 space and district heating projects, and 10 industrial projects.

The consumer of direct-use geothermal energy can count on savings of as much as 80% from traditional fuel costs, depending on the application and the industry. Direct-use systems do require a larger capital investment, but have lower operating costs and no need for ongoing fuel purchases.

Geothermal Heat Pumps

The geothermal heat pump doesn't create electricity—but it greatly reduces consumption of it. Geothermal heat pump systems consist of three parts: the ground heat exchanger, the heat pump unit, and the air delivery system (ductwork). In the winter, the geothermal heat pump removes heat from the ground heat exchanger and pumps it into the indoor air delivery system. In the summer, the process is reversed and the geothermal heat pump moves heat from the indoor air stream into the ground heat exchanger.



DOE's Office of Geothermal Technologies

Our Mission

To work in partnership with U.S. industry to establish geothermal energy as a major sustainable, environmentally sound, economically competitive contributor to the world's energy supply.

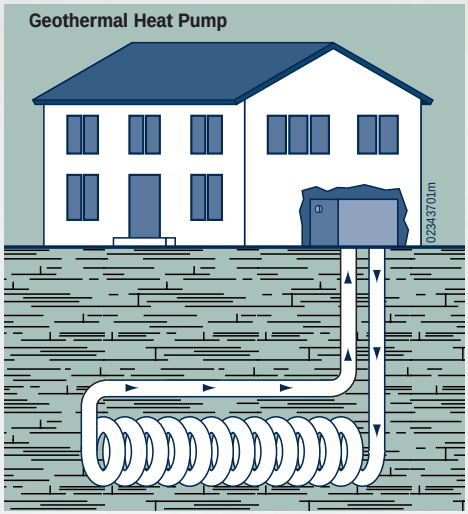
Our Vision

By the year 2005, the U.S. geothermal industry will lead the world in providing geothermal energy at competitive prices.

Office of Geothermal Technologies

DOE's Office of Geothermal Technologies (OGT) sponsors research aimed at developing the science and technology necessary for tapping geothermal resources more fully.

Through its field offices and national laboratories, OGT works closely with industry to develop advanced technologies. Much of OGT's cooperative work with industry is coordinated and funded by one of three cost-share organizations: the Geothermal Technology Organization, the Geothermal Drilling Organization, and the Geothermal Power Organization. These three organizations give priority to funding near-term development projects that address the most challenging hurdles to future development of geothermal energy.



Geothermal Energy Tomorrow

- The geothermal industry, with assistance from OGT, is working to achieve a geothermal life-cycle energy cost of 3¢ per kilowatt hour.
- Developing countries, nearly half of which have geothermal resources, will continue to be attractive export markets for geothermal technologies and expertise.
- By the turn of the century, 400,000 homes and commercial buildings will be installing geothermal heat pumps each year.

Who To Contact

U.S. Department of Energy (DOE)
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http://www.eren.doe.gov/geothermal/

Energy and Geoscience Institute
423 Wakara Way, Suite 300
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(801) 581-5126
http://www.egi.utah.edu/

Geo-Heat Center
Oregon Institute of Technology
3201 Campus Drive
Klamath Falls, OR 97601-8801
(503) 885-1750
http://www.oit.osshe.edu/~geoheat/

Geothermal Education Office
664 Hilary Drive
Tiburon, CA 94920
(800) 866-4GEO
http://geothermal.marin.org

Geothermal Energy Association
122 C Street N.W., Suite 400
Washington, DC 20001
(202) 383-2676
http://www.geotherm.org

Geothermal Heat Pump Consortium, Inc.
701 Pennsylvania, N.W.
Washington, DC 20004-2696
(800) ALL-4GEO (255-4436)
http://www.ghpc.org/

Geothermal Resources Council
2001 Second Street, Suite 5
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(916) 758-2360
http://www.demon.co.uk/geosci/grcdoc.html

International Ground Source Heat Pump Association
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http://www.igshpa.okstate.edu/

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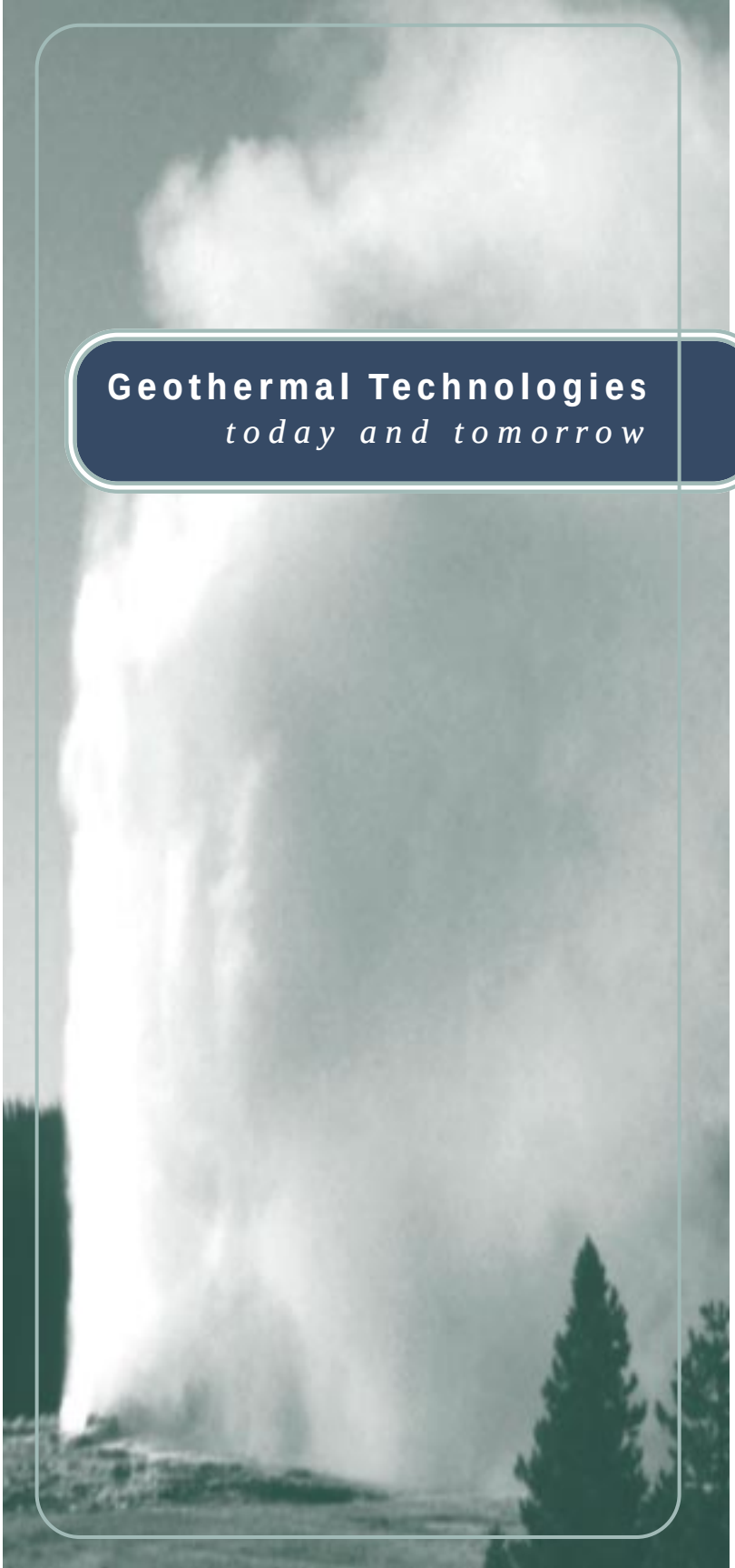

Geothermal Technologies

today and tomorrow